

EXPLOSION PROTECTIVE SYSTEM

This application claims priority to, and incorporates by reference, U.S. Provisional Patent Application No. 60/411, 150 filed September 17, 2002.

BACKGROUND OF THE INVENTION

[0001] The present invention relates generally to the protection of
5 assets from an explosion, and, more particularly, to a protective system using
plates to absorb and deflect explosive forces.

BRIEF SUMMARY OF THE INVENTION

[0002] The invention includes methods and an apparatuses for the
protection of ships, docks and other structures. The protection of these and other
10 objects is vitally important to the safety and security of our ports. Especially in the
current environment, a method for protection from explosives and, for example,
watercraft used as explosive projectiles, is needed. The invention involves steel
plating with air chambers and a system of steel disks stacked together. The disks can
be pre-compressed. The invention has a horizontal travel distance to absorb and
15 deflect explosive energy. Air is used in a chamber to dissipate shockwave energy
from explosives and steel is used to deflect and absorb the forces resulting from the
explosion. The invention can be completely submerged or can rise above the water
level and still offer protection from sub-surface attacks. The invention is not limited
to the protection of ships, but is also useful for protecting docks, piers, and other
20 marine structures. The shock energy travels at supersonic speed. Many materials
cannot react, structurally, fast enough to effectively deal with energy traveling at such
high speeds.

[0003] Air chambers can dissipate energy much more efficiently than
water in an underwater explosion. As a example, when a gas bubble from an
25 explosion breaches the water surface, a great deal of the energy from the explosion is
dissipated. Different explosives have varying characteristics of gas bubbles when
detonated. Molecular explosives such as C-4, Tritenol, and PETN based products
have much less of a gas bubble than an Ammonium Nitrate product mixed with an
oxidizer. In order to account for different explosive characteristics, the system has

both strength and mobility. In this protective system, channeling the energy and dissipating the energy are both extremely important.

[0004] The system can also be employed for land based structures.

[0005] Particular embodiments of the invention provide a blast protection
 5 system for protecting an asset from a blast force. The system has a shaft; a plurality of plates mounted on the shaft; a panel attached to a first plate of the plurality of plates and for receiving the blast force and transmitting a portion of the blast force to the first plate; and a base attached to a second plate of the plurality of the plates and for receiving a portion of the force transmitted to the first plate by the panel. The
 10 force received by the base is less than the blast force.

[0006] Other embodiments of the invention provide a method of protecting an asset from a blast force. The method includes receiving the blast force with a panel; transmitting a portion of the blast force from the panel to a first plate of a plurality of plates, the plurality of plates being mounted on a shaft; and transmitting
 15 a portion of the force transmitted to the first plate to a base attached to a second plate of the plurality of the plates. The force transmitted to the base is less than the blast force.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] The foregoing and other features and advantages of the
 20 invention will be apparent from the following, more particular description of preferred embodiments of the invention, as illustrated in the accompanying drawings wherein like reference numbers generally indicate identical, functionally similar, and/or structurally similar elements.

[0008] Figure 1 shows an exploded view of an embodiment of the
 25 invention;

[0009] Figure 2 shows an example of an embodiment of the invention;

[00010] Figure 3 shows an example of another embodiment of the
 invention; and

[00011] Figure 4 shows an example of another embodiment of the
 30 invention in use.

DETAILED DESCRIPTION OF THE INVENTION

[00012] Embodiments of the invention are discussed in detail below.

[00013] The invention absorbs the blast and dissipates the energy of an explosion. When a blast is detonated, the energy tends to travel upward. The release of this energy typically follows the path of least resistance. If the blast has forward momentum, then it will tend to go forward. A blast mitigation system must be resistant in the direction of the momentum of the explosion. In water, the blast will try to go upward because the gas bubble of the explosion process is less dense than the water in which the explosive was detonated. In air or on the surface of the land, the blast will also tend to rise because of the difference of density of the ground and the air. If a building is attacked from a vehicle carrying explosives it will have to resist horizontal and vertical force. When explosives are left on a surface and detonated, most of the energy will go into the air instead of traveling into the ground. The blast mitigation system will respond more in the horizontal plane than in the vertical plane. When explosives are detonated in a borehole (underground) there is a cone of energy shaped like an upside-down ice-cream cone in the ground.

[00014] Systems in accordance with the invention will deflect the horizontal forces of the explosion upward and outward and also absorb (by moving at a slower pace than the shockwave energy of the explosive) the remaining horizontal component of the explosive. This is achieved by compressed disks such as, for example, Belleville Springs. Particular disks can absorb approximately 40,000 pounds of force, but higher forces can be absorbed by disks of different shapes and sizes. The disks can be stacked and attached to bolts (steel sleeves) with concave and convex disks opposing each other. The disks (one or more facing one direction stacked next to one or more facing the opposing direction) are stacked on a sleeve so they can slide and absorb/deflect the energy much quicker and more efficiently than a solid structure could. Panels are attached to the explosion side of the disks. The shape of the panels should take the energy and spread it out. This can be achieved by, for example, a shape that is sloping in nature like a hemisphere or a pyramid turned sideways with the smallest end pointing out toward the blast. In particular embodiments of the invention, a dimpled surface is provided on the panels. A

dimpled surface (like a golf ball) can absorb and deflect more energy than a plain flat surface can because it has more surface area to accept the effects of a blast.

[00015] In experiments, an example of the system withstood forces of over 1,000,000 pounds for over 1,000 detonations. Since the detonation of explosives happens in milliseconds, the system must be extremely dynamic. While dynamic, it must still retain its rigidity.

[00016] The invention can be a modular system able to adapt to various heights and widths with, for example, a bolt-together, interlocking system. The shapes and patterns can be modified as needed for differing applications. The system is preferably modular so that sections of the system can be attached together vertically and horizontally to protect structures of differing height and width. For example, a ship or a building would need a different size system than would a barricade for a road.

[00017] Figure 1 shows an example of the invention in which five disks 100 are positioned such that their convex sides 110 face to the left and their concave sides 120 face to the right. Similarly, five disks 200 are positioned such that their convex sides 210 face to the right and their concave sides 220 face to the left. Disks 100, 200 are positioned on a sleeve or shaft 300 on which they can slide. Disks 100, 200 are shown spaced apart from each other in Figure 1 for clarity. Figure 2 shows two sets of disks 100, 200 like the set shown in Figure 1, but pressed against each other so that all the disks contact at least one other disk.

[00018] Figure 3 shows an assembly similar to that shown in Figure 2 (but having three sets of disks instead of two) mounted between a panel 400 and a base 500. In this example, spacers 320 are shown on sleeve 300 between inside disk 100 and base 500 and between outside disk 200 and panel 400. In other embodiments, no spacers are used and the stack of disks is tightly held between panel 400 and base 500. Whatever structure is used, it is preferable to hold the disks tightly between panel 400 and base 500 so that when the system absorbs a blast, the disks will not be slammed against either panel 400 or base 500. Such slamming can cause breakage of the disks. In some embodiments, the stack of disks is pre-stressed so that the disks are pressed against each other with, for example, 1000 pounds of force. The

existence and amount of pre-stressing can be adjusted according to the application and type of disks used.

[00019] Panel 400 can take many shapes such as, for example, an angled surface as shown in Figures 3 and 4, a cone with its small end pointing away from the disks, a hemisphere, etc. The surface of panel 400 that is opposite the disks is the surface that is subjected to the blast. The shape of this surface is important to determine what portion of the blast is deflected and what portion is absorbed by the disks. Base 500 can be, but does not need to be, anchored in place by, for example, a buoy floating in the water or a rigid structure. One or both of panel 400 or base 500 can slide on sleeve 300 so that disks 100, 200 can flex to absorb force from the blast.

[00020] Figure 4 shows six assemblies similar to that shown in Figure 3 together in a system. The system shown in Figure 4 is positioned between an anticipated blast zone 70 and an asset 10 (such as a ship, building, etc.). A buffer zone 50 can be provided between base 500 and asset 10. Buffer zone 50 can be, for example, an air gap or be filled with styrofoam or other energy absorbing material.

[00021] While the examples discussed have particular numbers and orientations of disks, it is noted that any appropriate number of disks and any orientation of the disks can be used. For example, one pair of disks on a sleeve with their concave sides facing each other may be appropriate for a system designed to protect against small blasts. On the other hand, four (or more) pairs of disks on a sleeve with each pair having their concave sides facing each other may be appropriate for protection against more powerful blasts. Further, for protection against even more powerful blasts, one or more disks may be positioned with its concave side facing the convex side of the disk adjacent to it. Along these lines, combinations of number and orientation of the disks can be used to tailor the system to the particular level of blast expected.

[00022] The embodiments illustrated and discussed in this specification are intended only to teach those skilled in the art the best way known to the inventors to make and use the invention. Nothing in this specification should be considered as limiting the scope of the invention. All examples presented are representative and non-limiting. The above-described embodiments of the invention may be modified or varied, without departing from the invention, as appreciated by those skilled in the art

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in light of the above teachings. It is therefore to be understood that the invention may be practiced otherwise than as specifically described.